Facial Feature Extraction Based on the Smallest Univalue Segment Assimilating Nucleus (SUSAN) Algorithm

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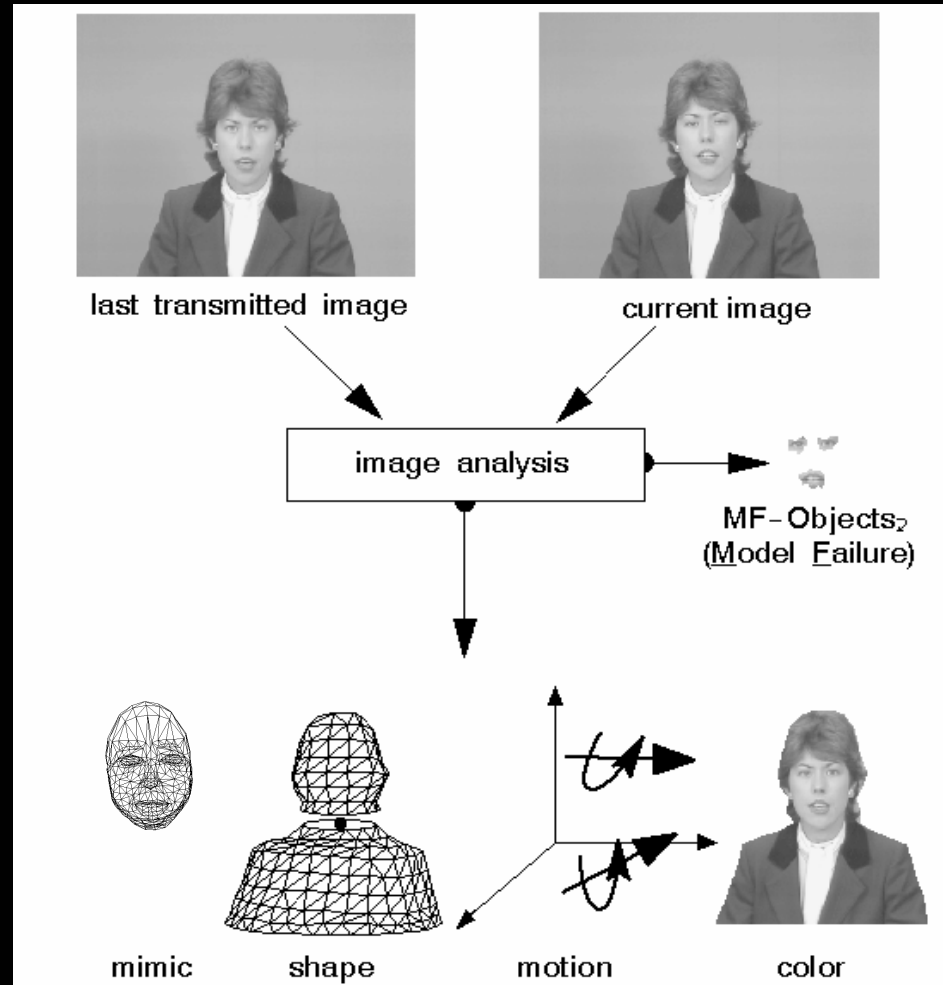Escuela de Ingeniería Eléctrica
Universidad de Costa Rica

PCS-2004

Overview

- Motivation
- Problem
- Approach
- Algorithm
- Results
- Summary

Motivation (1)

- Model-based coding

last transmitted image   current image

image analysis

MF-Objects₂
(Model Failure)

mimic   shape   motion   color
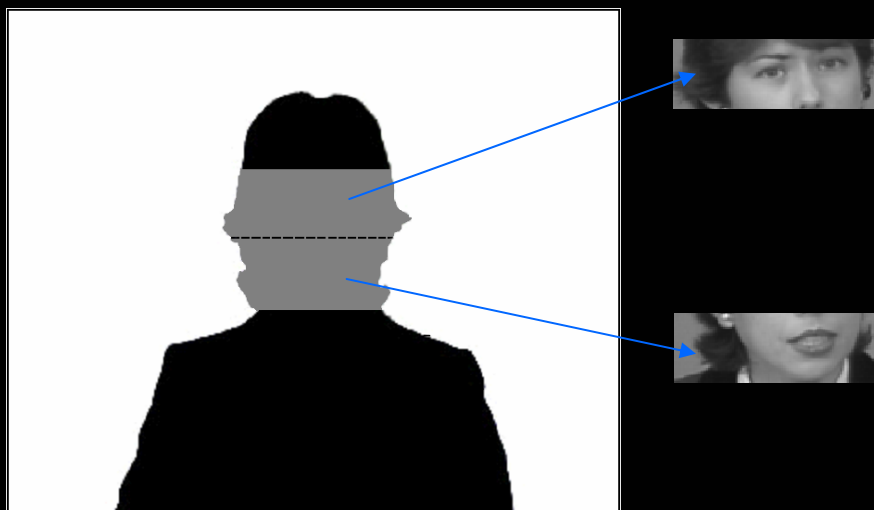
Motivation (2)

- At the beginning of the image sequence, the model must be adapted to the real face:

    - Face segmentation
    - Facial feature extraction
        - i.e. eyes and mouth corners,
        - Chin and cheek borders
    - Face model adaptation
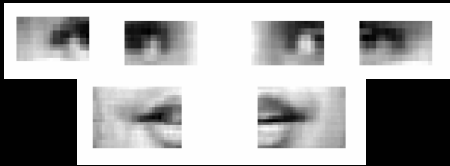

Adaptation algorithm
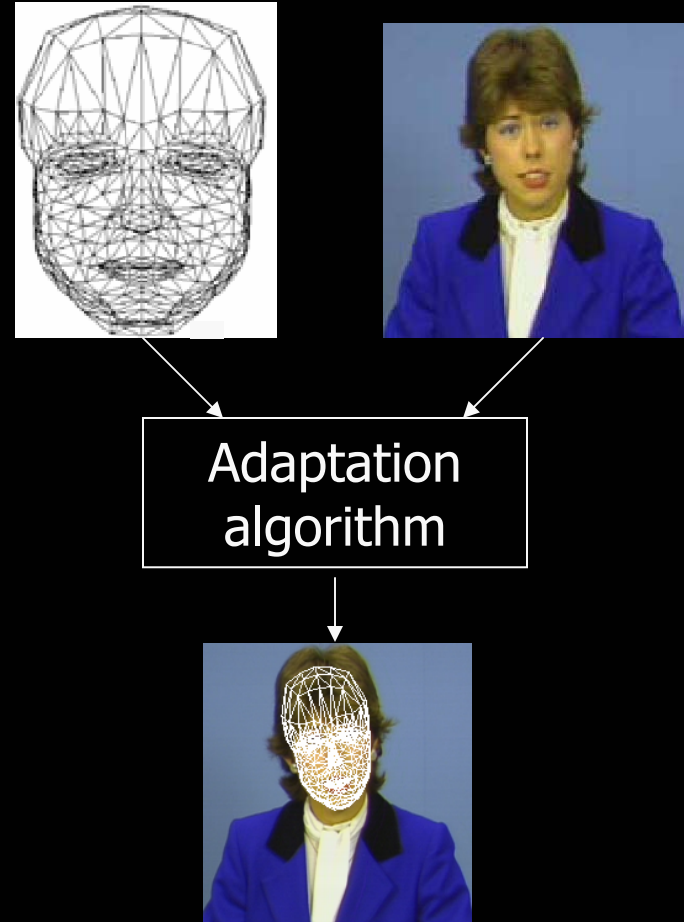
Motivation (3)

- Face segmentation

  - The face is segmented splitting the object silhouette into head and shoulders and then removing the upper third of the head

  - The silhouette is estimated by a change detection algorithm

Motivation (4)

- Artificial template matching for eyes and mouth corners extraction
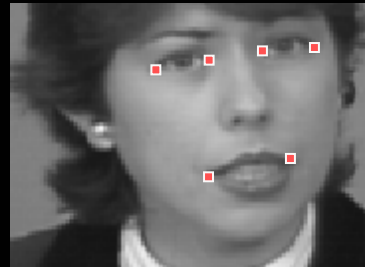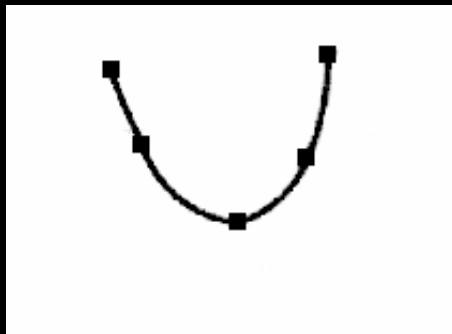
artificial templates

search regions

Template matching

Motivation (5)

- Deformable Template Matching for chin and cheek borders extraction
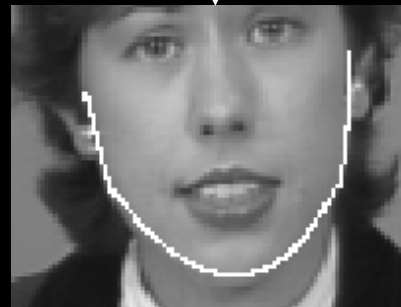
deformable parabolas

deformable template matching

search regions

linear intensity gradients

Problem

- Artificial template matching fails when applied to images different than those used to generate the artificial templates

- Parabolas are not flexible enough for description of chin and cheek borders

Approach

- First, all corners and borders are extracted using the Smallest Univalue Segment Assimilating Nucleus (SUSAN) algorithm

- Then, the facial features are detected from the extracted corners and borders by using knowledge based rules

Corner and border extraction

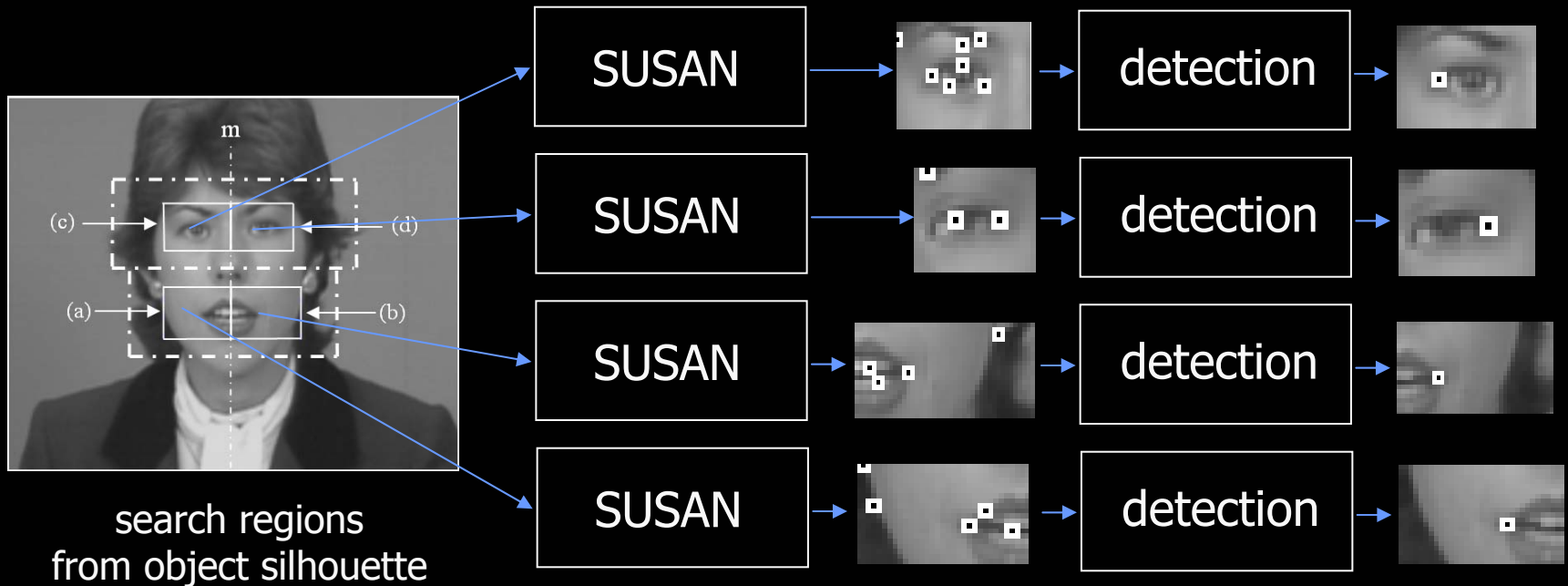- Smallest Univalue Segment Assimilating Nucleus (SUSAN) algorithm
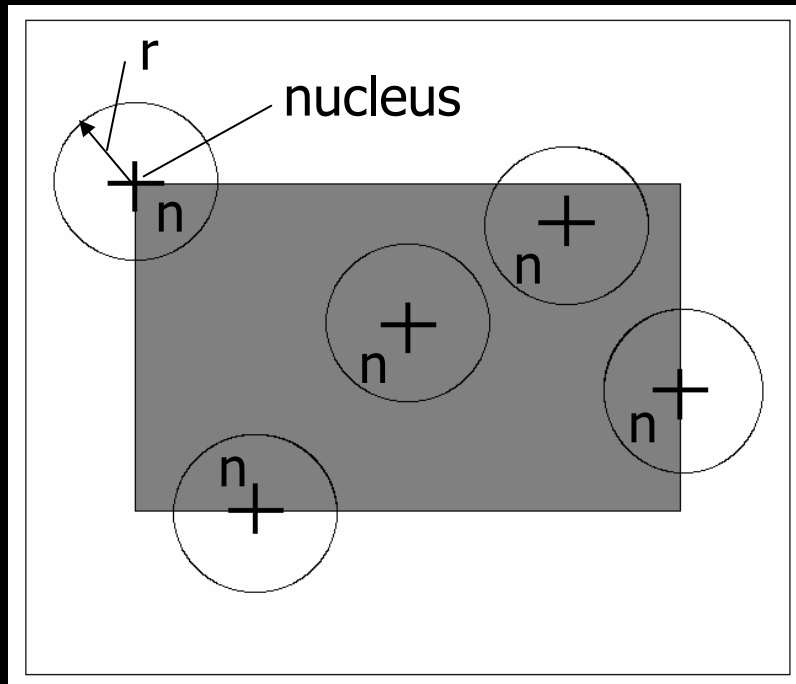
n=USAN area

if $n \approx \pi \cdot r^2 \cdot \frac{1}{2}$ —› straight border

if $n \ll \pi \cdot r^2 \cdot \frac{1}{2}$ —› corner

Algorithm (1)

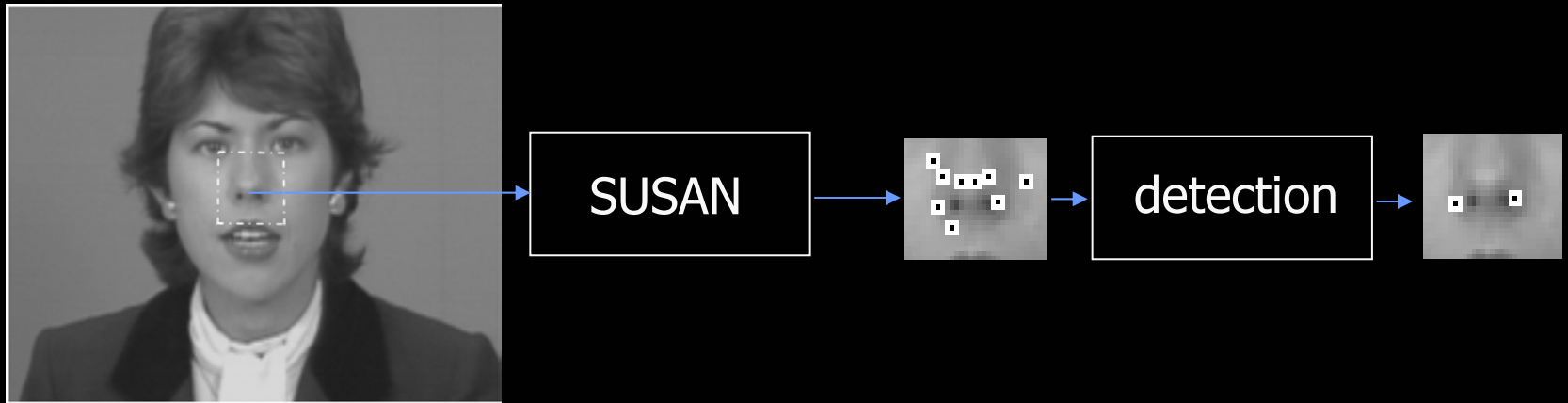- Extraction of the mouth corners and outer corners of the eyes

search regions
from object silhouette

Algorithm (2)

- Detection of the left mouth corner (example)

detection

eliminate corners where a/b>0.35

eliminate corners with higher border concentration to their left than to their right

select the corner located most to the left
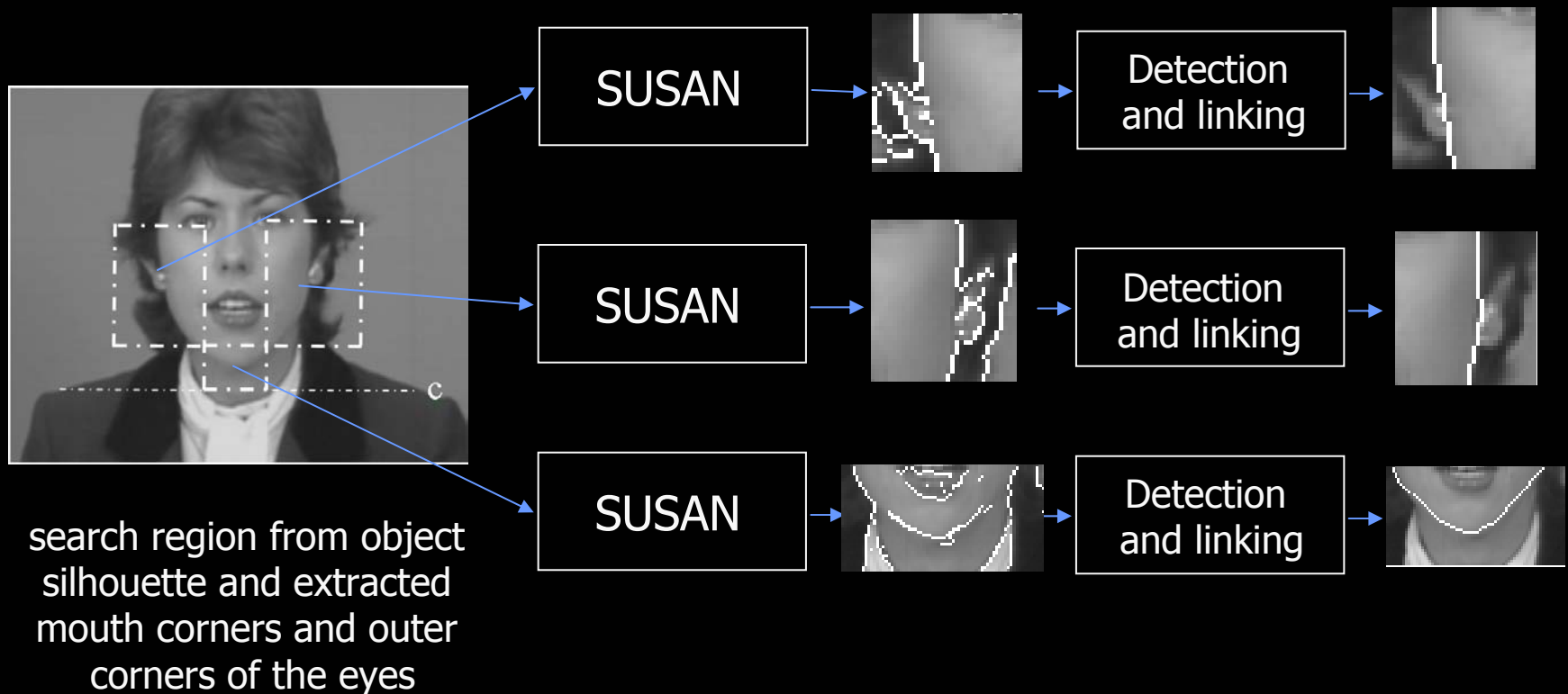
Knowledge-based rules
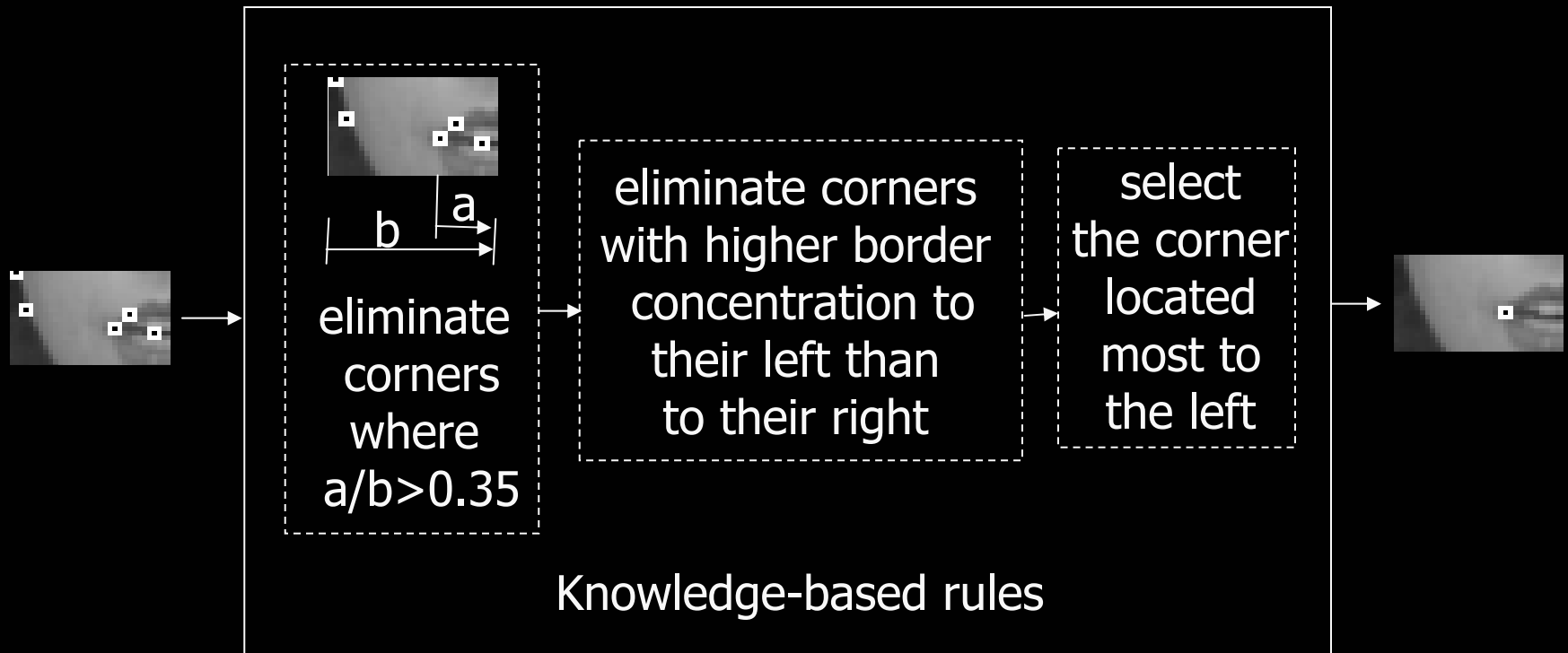
Algorithm (3)

- Extraction of the nose corners

search region from extracted
mouth corners and outer
corners of the eyes

SUSAN → detection

Algorithm (4)

- Extraction of the chin and cheek borders

search region from object silhouette and extracted mouth corners and outer corners of the eyes
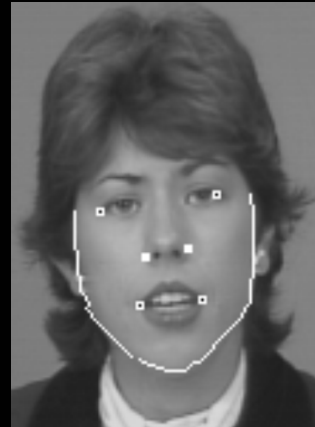
Results (1)

- Data:
  - 40 frames of test sequence Claire (CIF, 10 Hz)

- Average processing time:
  - 0.2 sec/frame

- Reliability:
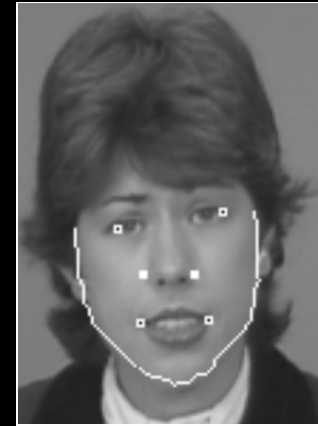 - all facial features could be extracted in 85% of the frames
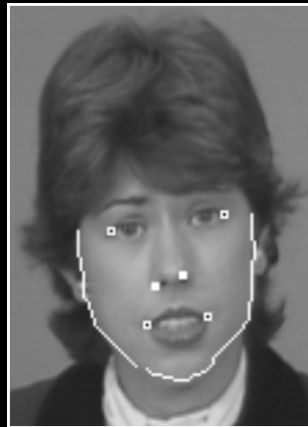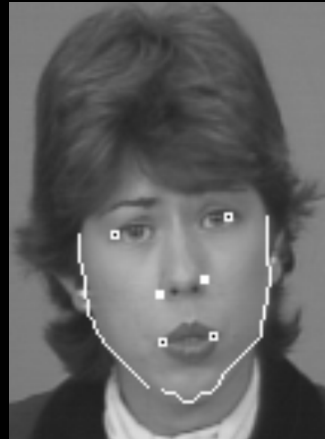
Results (2)

4th frame, *Claire*

7th frame, *Claire*

12th frame, *Claire*

14th frame, *Claire*

17th frame, *Claire*

29th frame, *Claire*

Results (3)

- Position error of the mouth corners and outer corners of the eyes:
  - 2.3 ± 0.9 pixels

- Position error of the nose corners:
  - 3.7 ± 1.9 pixels

- Position error of the chin and cheek borders:
  - 1.1 ± 0.8 pixels

Summary

- First, all corners and borders are extracted using the SUSAN algorithm

- Second, the facial features are detected from the extracted corners and borders using knowledge-based rules

- All facial features were extracted in 85% of the frames